Tetra Tech, Inc.
DATA VALIDATION REPORT
LEVEL IV

Site:	West Lake Landfill Site, Bridgeton, Missouri
Laboratory:	TestAmerica Laboratories, Inc. (Earth City, Missouri)
Data Reviewer:	Harry Ellis, Tetra Tech, Inc. (Tetra Tech)
Review Date	May 9, 2016
Sample Delivery Group (SDG):	J15647
Sample Numbers:	SED 1-EPA DUP, SED 2-EPA DUP, and SED 4-EPA DUP
Matrix / Number of Samples:	3 Sediment Samples

The data were qualified according to the U.S. Environmental Protection Agency (EPA) Region 7 documents entitled "Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Methods Data Review" (9355.0-131), August 2014. In addition, the Tetra Tech document "Review of Data Packages from Subcontracted Laboratories" (February 2002) and the EPA and others document "Multi-Agency Radiological Laboratory Analytical Protocols Manual" (July 2004) were used along with other criteria specified in the applicable methods.

The review was intended to identify problems and quality control (QC) deficiencies that were readily apparent from the summary data package. The following sections discuss any problems or deficiencies that were found, and data qualifications applied because of non-compliant QC. The data review was limited to the available field and laboratory QC information submitted with the project-specific data package.

I, Harry Ellis, certify that all data validation criteria outlined in the above-referenced documents were assessed, and any qualifications made to the data accorded with those documents.

Harry N. Ellis III

9 May 2016

Certified by Harry Ellis, Chemist — Date

DATA VALIDATION QUALIFIERS

U — The analyte was not detected above the reported sample quantitation limit.

J — The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

UJ — The analyte was not detected above the reported sample quantitation limit, which is estimated.

R — The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet QC criteria. Presence or absence of the analyte cannot be verified.

DATA ASSESSMENT

Sample delivery group (SDG) J15647 included three (3) environmental sediment samples and no QC samples. The samples were analyzed for thorium and uranium isotopes by alpha spectroscopy, using DOE Method A-01-R, and for radium-226 and other isotopes by gamma spectroscopy, using EPA Method GA-01-R. The following summarizes the data validation that was performed.

ALPHA SPECTROSCOPY ANALYSES

I. Holding Time and Chain of Custody (COC) Requirements

The samples were received by the laboratory and analyzed within the established holding time of 6 months from sample collection to analysis. No data were qualified.

II. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were not performed in these analyses. No qualifications were applied for this data gap. LCS and duplicate analyses provided adequate confirmation of accuracy and precision.

III. Blanks

The laboratory (method) blanks yielded low activities for thorium-228 and thorium-230. All sample results for these analytes were more than 10 times their blank activities, so they were not qualified.

IV. Laboratory Control Sample (LCS)

All percent recoveries and relative percent differences from the LCS analyses were within established control limits. No qualifications were applied.

V. Tracers

The tracers (thorium-229 and uranium-232) yielded fully satisfactory recoveries from the field samples and the LCS, but an excessive recovery of thorium-229 from the method blank. No qualifications were applied to the field sample results.

VI. Calibrations and other Quality Control measures

All calibrations (including initial, annual verification, monthly, and daily) were within QC limits. Monthly background checks were also within limits.

VII. Comments

All samples contained rocks that were removed before homogenization. The reported results are representative of the sample portion remaining following removal of the rock.

VIII. Overall Assessment of Data

Overall data quality is acceptable, with no qualifications applied. All data are usable as reported for their intended purposes.

GAMMA SPECTROSCOPY ANALYSES

I. Holding Time and Chain of Custody (COC) Requirements

The samples were received by the laboratory and analyzed within the established holding time of 6 months from sample collection to analysis. The preferred 21-day ingrowth period was performed before determination of the radium. No data were qualified.

II. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD analyses were not performed in these analyses. No qualifications were applied for this data gap. LCS and duplicate analyses provided adequate confirmation of accuracy and precision.

III. Blanks

The laboratory (method) blank yielded low activities of lead-210, thallium-208, and uranium-235. The reported activities of lead-210 in all samples and uranium-235 in one were less than 10 times the blank activity. Therefore these results were qualified as estimated, possibly biased high, and flagged "J". The other results were either more than 10 times the blank results (thallium-208) or undetected (uranium-235), so no further qualifications were applied.

IV. Laboratory Control Sample (LCS)

All percent recoveries from the LCS analyses were within established control limits. No qualifications were applied.

V. Tracers

Tracers are not used in these radioanalytical methods.

VI. Calibrations and other Quality Control measures

All calibrations (including initial, annual verification, monthly, and daily) were within QC limits. Monthly background checks were also within limits.

VII. Comments

All samples contained rocks that were removed before homogenization. The reported results are representative of the sample portion remaining following removal of the rock.

VIII. Overall Assessment of Data

Overall data quality is acceptable, with no significant qualifications applied. All data are usable as qualified for their intended purposes.

Client Sample ID: SED 1-EPA DUP

Date Collected: 01/06/16 09:20
Date Received: 01/08/16 11:57

Lab Sample ID: 160-15647-1
Matrix: Solid

Method: A-01-R - Isotopic Thorium (Alpha Spectrometry)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
Thorium-228	0.699		0.152	0.163	0.0722	0.0242	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Thorium-230	3.25		0.322	0.422	0.0596	0.0179	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Thorium-232	0.693		0.148	0.159	0.0442	0.0103	pCi/g	01/13/16 14:15	01/22/16 12:51	1

Tracer	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Thorium-229	*90.4*		*30 - 110*	*01/13/16 14:15*	*01/22/16 12:51*	*1*

Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
Uranium-233/234	0.748		0.184	0.194	0.0785	0.0227	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Uranium-235/236	0.0283		0.0490	0.0490	0.0890	0.0239	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Uranium-238	0.737		0.181	0.191	0.0502	0.00856	pCi/g	01/13/16 14:15	01/21/16 11:14	1

Tracer	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Uranium-232	*86.4*		*30 - 110*	*01/13/16 14:15*	*01/21/16 11:14*	*1*

Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
Actinium-227	0.247	U	0.755	0.756	1.29	0.605	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Actinium 228	0.616		0.257	0.265	0.453	0.202	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Bismuth-212	-0.00534	U	0.675	0.675	1.27	0.555	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Bismuth-214	1.08		0.196	0.226	0.142	0.0596	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Lead-210	1.99	J	1.68	1.70	2.56	1.19	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Lead-212	0.766		0.157	0.185	0.165	0.0760	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Lead-214	1.27		0.198	0.238	0.207	0.0939	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Potassium-40	9.17		1.80	2.03	1.67	0.739	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Protactinium-231	-0.146	U	1.40	1.40	2.50	1.14	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Radium-226	1.08		0.196	0.226	0.142	0.0596	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Radium-228	0.616		0.257	0.265	0.453	0.202	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Thorium-232	0.616		0.257	0.265	0.453	0.202	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Thorium-234	1.28		1.52	1.52	2.58	1.22	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Thallium-208	0.323		0.0863	0.0926	0.0842	0.0360	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Uranium-235	0.0144	U	0.0369	0.0369	0.516	0.240	pCi/g	01/12/16 10:04	02/02/16 09:20	1
Uranium-238	1.28		1.52	1.52	2.58	1.22	pCi/g	01/12/16 10:04	02/02/16 09:20	1

Other Detected Radionuclides	*Result*	*Qualifier*	*Count Uncert. (2σ+/-)*	*Total Uncert. (2σ+/-)*	*MDC*	*DLC*	*Unit*	*Prepared*	*Analyzed*	*Dil Fac*
Other Detected Radionuclide	*None*						*pCi/g*	*01/12/16 10:04*	*02/02/16 09:20*	*1*

HWE 9 May 2016

Client Sample ID: SED 2-EPA DUP

Date Collected: 01/06/16 09:06
Date Received: 01/08/16 11:57

Lab Sample ID: 160-15647-2
Matrix: Solid

Method: A-01-R - Isotopic Thorium (Alpha Spectrometry)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
Thorium-228	0.738		0.162	0.174	0.0890	0.0319	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Thorium-230	3.33		0.335	0.437	0.0520	0.0134	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Thorium-232	0.651		0.148	0.158	0.0492	0.0121	pCi/g	01/13/16 14:15	01/22/16 12:51	1

Tracer	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Thorium-229	*84.5*		*30 - 110*	*01/13/16 14:15*	*01/22/16 12:51*	*1*

Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
Uranium-233/234	0.966		0.215	0.230	0.0802	0.0224	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Uranium-235/236	0.0266		0.0419	0.0419	0.0668	0.0114	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Uranium-238	0.935		0.211	0.225	0.0670	0.0158	pCi/g	01/13/16 14:15	01/21/16 11:14	1

Tracer	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Uranium-232	*80.2*		*30 - 110*	*01/13/16 14:15*	*01/21/16 11:14*	*1*

Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
Actinium-227	0.388	U	0.715	0.716	1.21	0.558	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Actinium 228	1.08		0.281	0.302	0.141	0.0445	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Bismuth-212	0.623		0.682	0.686	1.09	0.460	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Bismuth-214	1.50		0.252	0.297	0.173	0.0746	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Lead-210	3.91	J	1.80	1.86	2.59	1.20	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Lead-212	0.733		0.210	0.230	0.203	0.0947	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Lead-214	1.33		0.204	0.246	0.205	0.0928	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Potassium-40	10.0		1.79	2.06	1.22	0.506	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Protactinium-231	0.232	U	0.496	0.497	2.35	1.06	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Radium-226	1.50		0.252	0.297	0.173	0.0746	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Radium-228	1.08		0.281	0.302	0.141	0.0445	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Thorium-232	1.08		0.281	0.302	0.141	0.0445	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Thorium-234	0.215	U	0.424	0.425	2.86	1.37	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Thallium-208	0.277		0.0865	0.0912	0.0597	0.0235	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Uranium-235	0.323	J	0.237	0.239	0.358	0.160	pCi/g	01/12/16 10:04	02/02/16 09:19	1
Uranium-238	0.215	U	0.424	0.425	2.86	1.37	pCi/g	01/12/16 10:04	02/02/16 09:19	1

Other Detected Radionuclides	*Result*	*Qualifier*	*Count Uncert. (2σ+/-)*	*Total Uncert. (2σ+/-)*	*MDC*	*DLC*	*Unit*	*Prepared*	*Analyzed*	*Dil Fac*
Other Detected Radionuclide	*None*						*pCi/g*	*01/12/16 10:04*	*02/02/16 09:19*	*1*

HWG 9 May 16

Client Sample ID: SED 4-EPA DUP

Date Collected: 01/06/16 08:36
Date Received: 01/08/16 11:57

Lab Sample ID: 160-15647-3
Matrix: Solid

Method: A-01-R - Isotopic Thorium (Alpha Spectrometry)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
Thorium-228	**0.900**		0.171	0.187	0.0625	0.0193	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Thorium-230	**19.8**		0.794	1.84	0.0566	0.0164	pCi/g	01/13/16 14:15	01/22/16 12:51	1
Thorium-232	**0.833**		0.163	0.177	0.0489	0.0126	pCi/g	01/13/16 14:15	01/22/16 12:51	1

Tracer	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Thorium-229	*95.9*		*30 - 110*	*01/13/16 14:15*	*01/22/16 12:51*	*1*

Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
Uranium-233/234	**0.776**		0.188	0.199	0.0684	0.0174	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Uranium-235/236	**0.0314**		0.0494	0.0495	0.0851	0.0216	pCi/g	01/13/16 14:15	01/21/16 11:14	1
Uranium-238	**0.881**		0.199	0.212	0.0509	0.00868	pCi/g	01/13/16 14:15	01/21/16 11:14	1

Tracer	*%Yield*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Uranium-232	*90.6*		*30 - 110*	*01/13/16 14:15*	*01/21/16 11:14*	*1*

Method: GA-01-R - Radium-226 & Other Gamma Emitters (GS)

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	MDC	DLC	Unit	Prepared	Analyzed	Dil Fac
Actinium-227	0.140	U	0.777	0.777	1.34	0.631	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Actinium 228	**0.892**		0.233	0.250	0.282	0.115	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Bismuth-212	**0.588**		0.808	0.810	1.34	0.588	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Bismuth-214	**1.68**		0.293	0.341	0.203	0.0896	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Lead-210	**3.95**	J	2.22	2.27	2.97	1.40	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Lead-212	**0.776**		0.155	0.185	0.153	0.0704	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Lead-214	**1.94**		0.275	0.341	0.191	0.0864	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Potassium-40	**15.0**		2.17	2.66	1.01	0.401	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Protactinium-231	0.694	U	1.70	1.70	2.91	1.35	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Radium-226	**1.68**		0.293	0.341	0.203	0.0896	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Radium-228	**0.892**		0.233	0.250	0.282	0.115	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Thorium-232	**0.892**		0.233	0.250	0.282	0.115	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Thorium-234	0.469	U	0.875	0.877	2.82	1.35	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Thallium-208	**0.244**		0.0823	0.0861	0.0784	0.0330	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Uranium-235	0.146	U	0.316	0.317	0.581	0.274	pCi/g	01/12/16 10:04	02/02/16 09:25	1
Uranium-238	0.469	U	0.875	0.877	2.82	1.35	pCi/g	01/12/16 10:04	02/02/16 09:25	1

Other Detected Radionuclides	*Result*	*Qualifier*	*Count Uncert. (2σ+/-)*	*Total Uncert. (2σ+/-)*	*MDC*	*DLC*	*Unit*	*Prepared*	*Analyzed*	*Dil Fac*
Other Detected Radionuclide	*None*						*pCi/g*	*01/12/16 10:04*	*02/02/16 09:25*	*1*

HVG 9 May 16